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Understanding the Mismatch Between Coaches' and Players' Perceptions of Exertion

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Paper Type: Original Investigation

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Abstract

A mismatch between the intended training exertion by the coach and the perceived exertion by players is well established in sports. However, it is unknown if coaches are able to accurately observe exertion of individual players during training. Furthermore, the discrepancy in coaches' and players' perceptions has not been explained. ***Purpose:*** We aim to 1) determine the relation between intended and observed training exertion by the coach and perceived training exertion by the player and 2) establish if on-field training characteristics, intermittent endurance capacity and maturity status explain the mismatch. ***Methods:*** During two mesocycles of 4 weeks (November and March) intended (RIE), observed (ROE) and perceived (RPE) exertion were monitored of 31 young elite soccer players. External and internal training load were objectively quantified with accelerometers (PlayerLoad) and heart rate monitors (TRIMPmod). Interval Shuttle Run Test (ISRT) and age at peak height velocity (APHV) were determined for all players. ***Results:*** 977 training sessions were monitored with RIE, ROE and RPE. The correlations between RIE and RPE ($r=.58$; $p<0.01$) and ROE and RPE ($r=.64$; $p<0.01$) were moderate. The mean difference between RIE and RPE was -0.31 ± 1.99 and between ROE and RPE was -0.37 ± 1.87. Multilevel analyses showed that PlayerLoad and ISRT predicted RIE and ROE. ***Conclusion:*** Coaches base their intended and observed exertion on what they expect players will do and what they actually did on the field. When doing this, they consider the intermittent endurance capacity of individual players.

Keywords: Soccer, periodization, monitoring, intensity, training load, football

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Introduction

A mismatch between intended and perceived exertion is well established in individual and team sports. [1-10] It is suggested that this mismatch is even more pronounced in team sports like soccer, because training load during group exercises is difficult to control. [6] Moreover, coaches need to consider the individual characteristics of a large number of players on the field. It is assumed that discrepancies between intended and perceived exertion could lead to either under- or overtraining. [4] This is most delicate in the development of young players because inadequate training routines can lead to suboptimal performance and higher risk for injuries and illness. [11]

It has been suggested that coaches adjust their perceptions after observing training sessions. [7,8] Thus far, only two studies explored the ability of coaches to accurately observe the exertion of individual athletes. [7,8] These studies included tennis players and volleyball players and their coaches. The ratings of the tennis coaches before and after the training sessions were correlated and both underestimated the RPE of the player. This underestimation was confirmed in volleyball, particularly during physical training. However, if soccer coaches with teams up to twenty young players are able to observe intensity of individuals is not yet known.

Up to now, information about underlying factors that explain the mismatch between intended, observed and actual exertion is lacking. However, a better understanding of the sources of information that coaches uses may help to better calibrate their perceptions with that of players. A likely starting point is to consider what actually happens during the training session using technology such as accelerometers (external load) and heart rate monitors (internal load). Secondly, it is assumed that coaches consider the individual characteristics of players. An important individual characteristic that has great influence on the internal load is the intermittent

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endurance capacity. [12] Hence, it is useful to determine if coaches use information of intermittent endurance capacity when estimating intended and observed exertion. A third factor could be the maturity status of players [13], because first-year soccer players perceive training harder than second-year soccer players within one team. [6] In addition, maturity status has a substantial impact on intermittent endurance capacity. [14,15] A similar external training load could thus result in a different internal load based on the maturity status of players.

The aim of this study is to define the relation between intended and observed training load by the coach and perceived training load by the player. Furthermore, we aim to explain a potential mismatch between the intended and observed training load by the coach and perceived load of the players through on-field training characteristics, intermittent endurance capacity and maturity status.

Method

Subjects

Thirty-one players participated in the study; sixteen players from the U15 team (14.3±0.3 years, 56.3±12.9 kg, 168.1±11.1 cm) and fifteen players from the U17 team (16.3±0.2 year, 67.8±5.2 kg, 179.9±4.9 cm). Both teams played at the highest-level of competition in the Netherlands. Their coaches are certified to coach at the highest level, accredited by the Royal Dutch Football Association. The U17-coach and the U15-coach had 23 and 18 years of professional coaching experience respectively. All participants were informed of the procedures of the study and player and both parents signed an informed consent. The ethical committee of the Center for Human Movement Sciences (University of Groningen, UMCG, Groningen) approved the study.

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Design

During two mesocycles of four weeks (November and March) of the competitive season intended (RIE), observed (ROE) and perceived exertion (RPE) were monitored (figure. 1). The U15 team had five training sessions a week, one on every weekday. The U17 team had six training sessions each week with an additional strength training session on Tuesday afternoon. Once a week within both mesocycles, one training session was monitored using Zephyr Bioharnass to measure accelerations and heart rate. The U15 team was measured every Wednesday during the mesocycle and the U17 team every Thursday. At the start of the competitive season (September) all players performed the Interval Shuttle Run Test (ISRT) to assess the intermittent endurance capacity. Four weeks thereafter Age at Peak Height Velocity (APHV) of each individual was determined.

Methodology

Intended, observed and perceived exertion

To measure the intended, observed and perceived exertion a Borg scale from 6 (no exertion) to 20 (extreme exertion) was used. To quantify subjective training exertion, the Rate of Perceived Exertion is a frequently used and valid method. [16-18] Before each training the coach scored the Rate of Intended Exertion for all individual players of his team for the entire session. Right after the training session, the coach filled in the Rate of Observed Exertion for all individual players based on his observations of the whole training session. About thirty minutes afterwards, players gave their RPE for the whole training session. [16,17] In line with previous work we used the original Borg scale instead of the category ratio scale, because in the Netherlands school exams are graded on a 10 point scale. [6,11] This association could lead to ignorance of the lower half of the scale.

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PlayerLoad and heartrate

The Zephyr’s BioHarnessTM 3 (Zephyr Technology Corporation, Annapolis, MD, US) was used to measure external load with accelerometers and to measure internal load with heart rate. The accelerometer measures accelerations in three orthogonal components with a frequency of 100 Hz. The raw accelerometer data were in bits and had to be converted into m/s2. The accelerometer data was filtered with a second order Butterworth filter with a cut-off frequency of 4 Hz. The external load for each player can be defined as an arbitrary unit by the accumulation of the orthogonal components and correlates highly with covered distance. [19]

Second, heart rate was measured with a frequency of 1 Hz. The maximal heart rate of the players was determined during the maximal ISRT at the start of the season and used to calculate the TRaining IMPulse modified (TRIMPmod) for the whole training session. [20]

Intermittent endurance capacity

Intermittent endurance capacity was measured with a maximal ISRT. The ISRT is a valid and reliable method of measuring intermittent endurance capacity and the outcome correlates highly with VO_2max. [21,22] The test was performed at the start of training and consisted of 30 seconds of running alternated by 15 seconds of rest. The running speed increased every 90 seconds, started at 10 km/h and increased until 15 km/h. The instruction for the players was to achieve as many runs as possible.

Maturity status

To determine the maturity status, APHV was calculated. [23] The length and weight measurements took place four weeks after the ISRT measurement. Mass, stature and sitting height were measured according to the protocol of Ross et al. (1991). All players were dressed in

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shorts and did not wear shoes. Mass was recorded to nearest 0.5 kg; stature and sitting height were measured nearest to 1 mm. For stature, length was the maximum distance from the floor to the vertex of the head. Sitting height was maximal distance from the sitting surface to the vertex. The peak height velocity was calculated as described by Mirwald et al. [24] in which the ratio of leg length to sitting height is used. For boys the maturity offset = -9.236 + (0.0002708 * (leg length*sitting height)) + (0.007216 * (age*sitting height)) + (0.02292*(mass by stature ratio)).

Statistical analysis

Descriptive statistics and correlations were calculated using IBM SPSS statistics 23.0. Means and standard deviations of RIE, ROE, RPE, PlayerLoad, TRIMPmod, ISRT and APHV were calculated for both teams and all players. Paired sample T-tests were used to check differences between RIE and RPE and ROE and RPE. Only full training sessions of players were included. If players dropped out before completion of the full training session, or missed a training session due to injuries, illnesses or other reasons their sessions were excluded from further analyses.

Pearson correlation coefficients were calculated to examine the association between RIE and RPE and ROE and RPE. Pearson correlations were executed for all players (N=31) together. Criteria for the degree of correlation were set to: 0 zero association, 0-0.3 weak association, 0.4-0.6 moderate association, 0.7-0.9 strong association, 1 perfect association. [25] Thereafter, mean differences were calculated following Bland Altman procedures for agreement.

Predictors for intended and observed exertion were investigated using the multilevel modeling program MLwiN 2.29. Multilevel models are appropriate for investigating dependent data in which training sessions are nested within players and players are nested within teams, like in the current study. It also allows for a different number of training sessions completed per

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player when the missing data is random. In the multilevel analyses models for RIE and ROE were created. Levels 1 in these models were the different training sessions in which data was gathered. Levels 2 were the differences between individual players and levels 3 were the differences between both teams. Predictors entered for RIE and ROE were PlayerLoad, TRIMPmod, ISRT and APHV. Moreover, random intercepts were expected which means unique intercepts for all players. Also, random slopes were entered into the model to check for different slopes when predicting RIE and ROE for different players. Prediction variables were entered separately into the initial model. The order for entering the prediction variables was based on the correlation with of each variable with RIE and ROE, starting with the variable with the highest correlation. After addition of each variable the -2*loglikelihood (IGLS deviance) was compared to the previous model. Variables that did not improve the model significantly ($p<0.05$) were removed from further analysis. Predictions of the variables were calculated based on the final estimated model. Subsequently, the explained variance was calculated from the difference in variance between the initial and the final model. In all statistical analyses alpha was set to 5%.

Results

RIE, ROE and RPE were obtained from 977 training sessions (U15 445 sessions, U17 532 sessions). From these 977 sessions, 111 sessions (11% of all sessions, U15 46 sessions, U17 65 sessions) were measured using Zephyr to determine PlayerLoad and TRIMPmod. This corresponds with 3.6 sessions per player. Table 1 shows the means and standard deviations for all variables. RIE ($t=-4.89$, $df=976$, $p<0.001$) and ROE ($t=-6.19$, $df=976$, $p<0.001$) were significantly lower than RPE.

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Figure 2 shows the bivariate Pearson correlation coefficients for RIE, ROE and RPE. Correlation between RIE and RPE was r=.58 ($p<0.01$) and between ROE and RPE r=.64 ($p<0.01$).

Figure 3a depicts the Bland Altman plot of RIE and RPE. The mean difference was

-0.31±1.99, CI 95% [-0,43, -0,19] with a minimum of -6 and a maximum of 8. For ROE and RPE, the mean difference was -0.37±1.87, CI 95% [-0,49, -0,25] with a minimum of -7 and a maximum of 8 (figure 3b). No significant difference was found between these values.

The final models that explain RIE and ROE are presented in table 2. All models included significant different intercepts but the slopes were the same for different players. Both models included PlayerLoad and ISRT and improved the model significantly ($p<0.05$). TRIMPmod an APHV did not improve the model. The models explained 32% and 20% of the total variance for RIE and ROE, respectively. Training session (level 1) and team (level 3) contributed both to the total explained variance for both RIE and ROE.

Discussion

The first aim of this study was to determine the relation between intended and observed training exertion by the coach and perceived training exertion by the player. The moderate correlations between intended and observed exertion by the coach and perceived exertion by the player demonstrated a mismatch. Furthermore, we aimed to explain this mismatch through on-field training characteristics, intermittent endurance capacity and maturity status. The multilevel models showed that both external load and intermittent endurance capacity are predictors of the Rate of Intended Exertion and Rate of Observed Exertion and that internal load and maturity status are not.

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The moderate association between intended and perceived exertion is comparable with previous findings in young elite soccer players. [6] Although the correlation between observed and perceived exertion was somewhat stronger compared to intended and perceived exertion, coaches underestimated players perceived exertion before and after training. So, even when coaches decided to change their initial scores after observing training, the mismatch with the perceptions of players remained. This confirms previous findings that coaches are unable to accurately observe the internal load of players. [7,8] Thus, there is not only a discrepancy between intended exertion and perceived exertion but also between observed exertion and perceived exertion. The magnitude of these discrepancies is illustrated by the Bland Altman procedures. Although the mean difference was close to zero, the standard deviation of around 2 indicates that 32% of all pairings deviate more than 2 points with overestimations up to 8 points and underestimations up to 7 points.

The multilevel models of both intended exertion and observed exertion included external load and the interval endurance capacity. The external load of a training session usually includes the type of exercise, repetitions and duration as planned by the coach. Therefore, it can be argued that the intended external exertion by the coach should correspond with the external load of the players measured with PlayerLoad. Our results support this, given the predictive value of PlayerLoad in the model. Additionally, ISRT was a positive predictor of both intended and observed exertion. This reveals that the coach considers the intermittent endurance capacity of his players for the estimations, e.g. coaches estimate that players with a lower intermittent endurance capacity will perceive the training as harder.

In contrast to PlayerLoad and ISRT, TRIMPmod and APHV were not included in the final multilevel models. For TRIMPmod, a likely explanation is that the combination of external

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load (PlayerLoad) and the individual endurance capacity of players already reflect the internal load. Although TRIMPmod was related to intended and observed exertion, it did not improve the model. For APHV it turned out that almost all players of both teams already passed APHV. In addition, it is known that when players grow mature, intermittent endurance capacity also improves. [26,27] Thus, coaches might have included maturity status through accounting for ISRT in scoring intended and observed exertion.

The models in this study explained 32% and 20% of the variance respectively. This suggests that a large proportion remains unexplained. Several factors during training and before or after training may underlie this. First, static exercises like core-stability programs within training are not measured through PlayerLoad. Exclusion of these static exercises likely lower the RPE-values. [18] Moreover, TRIMPmod only represents the aerobic part of internal load. Activities such as jumps, sprints and resistance exercises during the training sessions refer to the anaerobic system and these were not measured using TRIMPmod. Finally, cognitively demanding tasks such as new tactical concepts within training can also increase RPE-values. [28] Since the explained variance for observed exertion was lower than for intended exertion, it appears that coaches used other information to adjust their observed exertion, e.g. sweating, breathing characteristics or face color.

Because observations of coaches predominantly focus on the relatively short period on the pitch, it is important to realize that off-pitch factors can also explain the discrepancy. It is assumed that the session RPE not only captures cardiovascular load, but also stress in personal lives of players, for instance school exams or family problems. [16] Accounting for these issues when planning training for a large squad is a difficult and complex task for coaches. Moreover, coaches might be unaware of activities undertaken by players in the ±22 hours between training

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sessions. A lack of recovery or additional physical activity at school could result in accumulated fatigue and a higher perceived exertion even if the external load is similar. [29]

A limitation of the study is that only two coaches participated. This is a common issue in coach-related research given the unfavorable coach player ratio. This restricts generalizability to other coaches. Indeed, differences between coaches exist and also occur in our study. Nonetheless, previous studies all support the mismatch between coaches and players' perceptions of exertion. [1-10]

Although application of monitoring systems in a practical setting often assumes a better insight in individual training load, this is not necessarily true. Future research should study potential changes in the discrepancy between coaches and players after an intervention with and without feedback on training load. In addition, studies must focus on the cognitive aspects of training load to better explain the mismatch. This is especially important because cognitive tasks impair physical performance. [30]

Practical applications

A consequence of a mismatch between intended and perceived exertion is that the periodization strategy is not executed as initially planned. If coaches are unable to observe the exertion of players, they cannot adjust their plan for the following training sessions appropriately. For instance, if players train less hard than planned during an intensive microcycle, performance of players will probably not improve. Providing coaches with feedback about internal training load may calibrate their perception and give better insight in the actual training load of individual players. Together, this may help them to improve and individualize training programs. It should be noted that this is only true under the assumption that coaches' training prescription is optimal and players are not able to self-regulate training intensity.

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Conclusion

Altogether, our study confirms a mismatch between intended and perceived exertion, but more importantly highlights that coaches were unable to accurately adjust the observed exertion after training. Together, these differences could lead to maladaptation of the players to the intended training program. When coaches rate the intended and observed exertion of the training session they consider the external training characteristics and the intermittent endurance capacity of the players. Since the explained variance for observed exertion was lower than for intended exertion, it appears that coaches used other information to adjust their perception.

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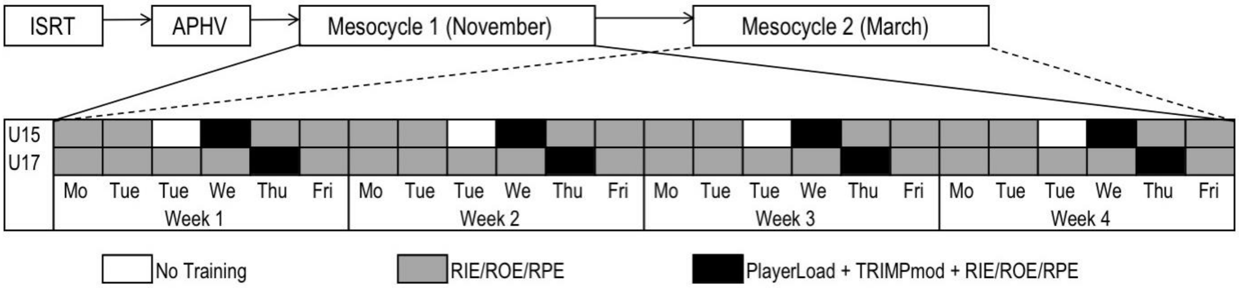

Figure 1. Overview of study design (two mesocycles of four weeks). ISRT: Interval Shuttle Run Test; APHV: Age of Peak Hight Velocity; TRIMPmod: Training IMPulse modified; Rate of Intended Exertion (RIE), Rate of Observed Exertion (ROE) and Rate of Perceived Exertion (RPE).

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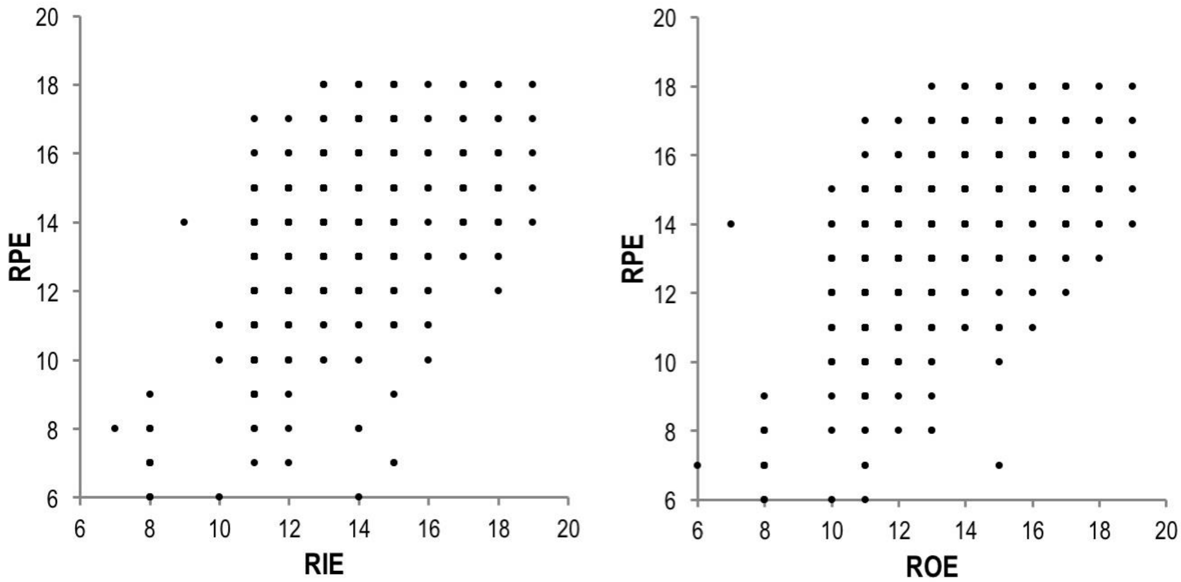

Figure 2. Relationships of Rate of Intended Exertion (RIE), Rate of Observed Exertion and Rate of Perceived (RPE) (N = 977).

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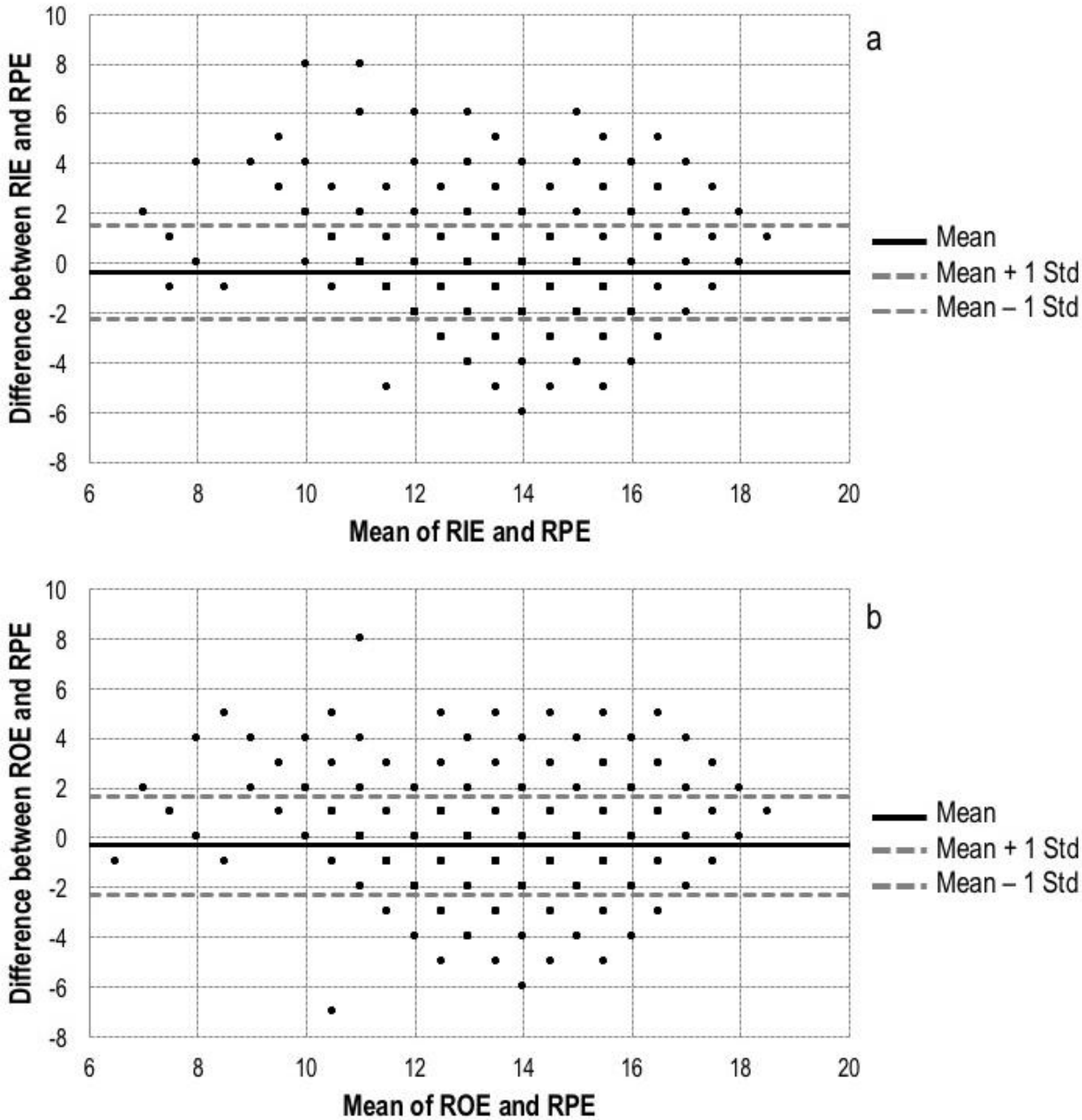

Figure 3. Bland Altman plots of Rate of Intended Exertion (RIE), Rate of Observed Exertion and Rate of Perceived Exertion (RPE) (N = 977).

"Understanding the Mismatch Between Coaches' and Players' Perceptions of Exertion"
by Brink MS, Kersten AW, Grencken WG
International Journal of Sports Physiology and Performance
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Table 1. Descriptive statistics of the Rate of Intended (RIE), Rate of Observed Exertion (ROE) and Rate of Perceived Exertion (RPE) and explanatory variables (N=31).

	Mean	±	std
RIE	13,3*	±	2,1
ROE	13,3*	±	2,2
RPE	13,6	±	2,2
PlayerLoad (au)	158,1	±	36,1
TRIMPmod (au)	113,4	±	43,1
ISRT (runs)	102,9	±	10,3
APHV (years)	13,8	±	0,7

* Significantly different from RPE (p<0.01).

TRIMPmod: TRaining IMPulse modified; ISRT: Interval Shuttle Run Test; APHV: Age of Peak Hight Velocity.

Table 2. Final multilevel models for Rate of Intended Exertion (RIE) and Rate of Observed Exertion (ROE).

RIE (R^2=0.32)			
Fixed effects	**Coefficient**	**Standard error**	**P[a]**
Intercept	14.022	0.938	<0.001**
PlayerLoad	0.005	0.002	0.012*
ISRT	-0.015	0.008	0.060
Random effects	**Variance**	**Standard error**	
Level 3 variance	0.397	0.408	
Level 2 variance	0.000	0.000	
Level 1 variance	0.328	0.045	
Deviance	192.811		
Deviance empty model	278.393		
ROE (R^2=0.20)			
Fixed effects	**Coefficient**	**Standard error**	**P[a]**
Intercept	10.081	1.501	<0.001**
PlayerLoad	0.013	0.003	<0.001**
ISRT	0.011	0.013	0.198
Random effects	**Variance**	**Standard error**	
Level 3 variance	0.569	0.587	
Level 2 variance	0.000	0.000	
Level 1 variance	0.954	0.132	
Deviance	305.563		
Deviance empty model	426.877		

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